THE BOTTOM FAUNA FROM THREE SUBTIDAL LOCATIONS AROUND BANKS PENINSULA, CANTERBURY, NEW ZEALAND

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ABSTRACT

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Epibenthic and benthic faunas were collected from various locations around Banks Peninsula, Canterbury during 1985-86. Epibenthic organisms were collected from three areas, while benthic faunas were sampled from two sites in one of these areas. Each area represented either a wave exposed, moderately wave exposed or sheltered shore type. Sediment types were dominated by either fine sand or silt and clay. A total of 58 species of invertebrate were collected from benthic samples, while 49 invertebrate and 5 vertebrate species were recorded from epibenthic samples. Forty-five epibenthic invertebrate species were found at the sheltered site; 30 at the exposed site; and 24 at the moderately exposed site. Amphipods numerically dominated epibenthic samples, while polychaetes dominated the benthos. Community composition varied between areas and seasons. Variation in community composition and species abundances is most likely explained by environmental factors, although the influence of predation pressure on community composition is also discussed.

KEYWORDS: benthic fauna - epibenthic fauna - subtidal - community composition.

INTRODUCTION

Within New Zealand there are very few quantitative studies on benthic faunas from shallow subtidal habitats. Local studies have suggested that invertebrates from subtidal habitats less than 30 m are usually dominated by molluscs, crustaceans and polychaetes (Fenwick 1978, Knox *et al.* 1978). The composition of benthic communities has traditionally been regarded as being determined by wave exposure, sediment type, and recruitment (Sanders 1958, Boesch 1973, Watling 1975, Kikuchi & Tanaka 1978). More recently, various authors have suggested that predation may also influence community composition (Virstein 1977, 1979, Blundon & Kennedy 1982, Boulding 1984). This present study describes the species composition of benthic and epibenthic faunas from selected sites around Banks Peninsula.

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STUDY AREA

Banks Peninsula is a volcanic promontory surrounded on three sides by the Pacific Ocean and on one side by the Canterbury Plains (Fig. 1). The Peninsula possesses many bays including the first two study sites, Little Akaloa and Taylors Mistake. Little Akaloa is 20 km east of Taylors Mistake and 24 km east of the third sample site, South Brighton Beach (Fig. 1). Little Akaloa is protected by Banks Peninsula on three sides but is open to the sea in the north. Taylors Mistake, the first bay on the northern side of the Peninsula is only partially protected from large northerly swells. Brighton Beach is situated where the Canterbury Plains meet with the Peninsula, and is typical of exposed east coast beaches in the area. Extensive studies have been carried out on the hydrology, bathometry and sediments of the Brighton area (Brodie 1960, Campbell 1974, Brown 1976).

MATERIALS AND METHODS

INFAUNAL BENTHIC COLLECTIONS

Infaunal benthic macroinvertebrates were collected in sediment samples from two 10 m^2 areas at Little Akaloa (Fig. 1). Benthic samples were collected with SCUBA using 0.125 m^2 cylindrical samplers, fitted at one end with 0.5 mm copper mesh. Five replicates were taken at each site to a depth of 187 mm at three-monthly intervals from June 1985 to March 1986 inclusive. Samples were sieved to 0.5 mm and the invertebrates identified and counted. Representative sediment samples were retained and sieved to Wentworth size classes for clay/silt, fine sand and coarse-fine sand.

Benthic invertebrate assemblages were described and community structure indices were calculated to compare with other studies. The Shannon-Weiner Index was chosen as it is the most commonly used measure of species diversity (Pielou 1966). This measure of diversity has the added advantage of being relatively sample-size independent.

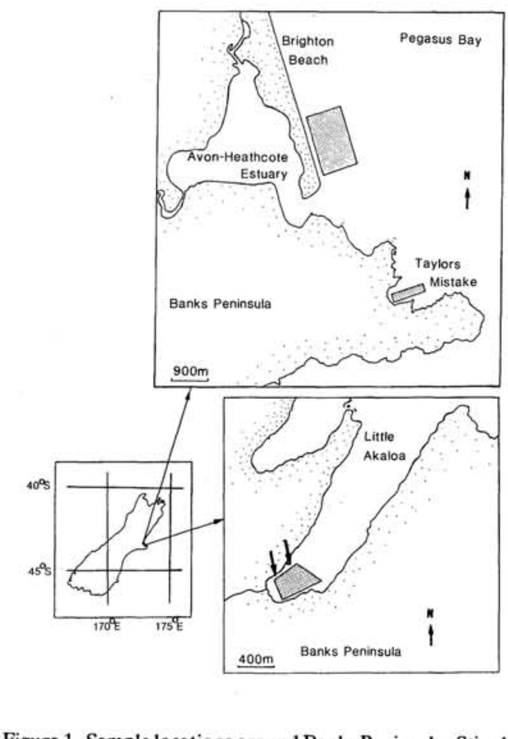

Figure 1. Sample locations around Banks Peninsula. Stippled areas indicate epibenthic collection sites, arrows indicate benthic collection sites.

It is defined as:

$$H = -\sum p_i \log_e p_i \quad \text{(Knox } et\ al. \text{ 1978)}$$

where p_i is the proportion of individuals belonging to the ith species.

This species diversity index has two components: a species richness component and an evenness component. These were calculated separately with Margalefs' (1958) measure of species richness defined as:

$$SR = (S\text{-}1) / (\log_e N)$$

where S is the number of species and N is the number of individuals; and evenness calculated as:

$$J = H / H_{max}$$

where H_{max} is $\log_e S$.

Fenwick (1984) working in a shelly sand benthos, recorded a critical depth for amphipod collection as approximately 40 mm. Similarly, Oliver *et al.* (1980) collected 85.2% of all crustaceans above this level. Very deep dwelling invertebrates may have been missed in my study. However, although no quantitative measurement of deep dwelling animals was possible, bivalve burrows were often excavated by hand.

EPIBENTHIC FAUNAL COLLECTIONS

Epibenthic macroinvertebrates and vertebrates associated with decaying drift algae were collected from Brighton Beach and Taylors Mistake during October 1984 and March 1985, and from Little Akaloa at three-monthly intervals from June 1984 to March 1985. Five replicates, each weighing approximately 150-200 g were collected from Otter and Beam Trawls and placed in plastic bags containing 10% formalin. Samples were sorted in the laboratory and the invertebrates separated, identified, counted and related to the wet weight of algae collected. The trawling method, although maintaining consistency over all samples, was primarily designed to capture paddle crabs, *Ovalipes catharus*. Trapped algae built up quickly in the cod end, thus capturing small epibenthic invertebrates, vertebrates and small algae. Some organisms, however, must have escaped through the 15 mm mesh.

RESULTS

SEDIMENT

Table 1 records the percent sediment composition of Brighton Beach, Taylors Mistake and Little Akaloa. The dominant sediment at the more exposed areas (Brighton Beach and Taylors Mistake) is fine sand. Silts and clays dominated at the sheltered Little Akaloa sites, forming 70.4% of the total sediment. Intensity of wave action and strong nearshore currents have sorted the sediments at each of the sample areas according to size, so that at the more exposed sites, the larger sediment sizes dominate.

Size Class (mm)	Sediment Type	Brighton[1] Beach	Taylors[2] Mistake	Little[3] Akaloa
< 0.0625	clay/silt	1.6%	21.0%	70.4%
0.0625-0.125	fine sand	48.4%	76.0%	27.7%
0.125-1.0	fine-coarse sand	41.0%	2.5%	1.9%

Table 1. Percent particle size composition of the sediment at each study site (Wentworth size classes).
[1]Knox *et. al.*, 1978,[2]Campbell, 1974,[3]this study.

BENTHIC FAUNA

Fifty-eight species of macroinvertebrate were recognized from benthic samples (Table 2). Twenty-four Polychaeta, 9 Mollusca and 8 Amphipoda were represented throughout the year. Within the Crustacea there were three species of Cumacea, 2 Ostracoda, 1 Leptostraca and a few representatives of the Decapoda, Isopoda and

- PHYLUM MOLLUSCA
  - Class Gastropoda
    - *Amalda australis*
  - Class Bivalvia
    - *Divaricella huttoniana*
    - *Dosinia* sp.
    - *Gari strangeri*
    - *Mactra ovata*
    - *Myadora striata*
    - *Nucula hartvigiana*
    - *Panopea zelandica*
    - *Tellina liliana*
    - *Tellina* sp.
- PHYLUM ANNELIDA
  - Class Polychaeta
    - *Aglaophamus* sp.
    - *Armandia* sp.
    - *Cirriformia* sp.
    - Cirratulidae sp.
    - *Cossura* sp.
    - *Glycera americana*
    - *Heteromastides filiformis*
    - *Lepidastheniella* sp.
    - *Lumbrineris* sp.
    - Maldanidae sp.
    - *Magelona papillicornis*
    - Nereidae sp.
    - Opheliidae sp.
    - *Ophelina* sp.
    - Orbinidae sp.
    - *Orbina papillosa*
    - Paraonidae sp.
    - *Pectinaria australis*
    - *Polydora* sp.
    - Sabellidae sp.
    - *Scoloplos* sp.
    - Sigalionidae sp.
    - Sphaerodoridae sp.
- PHYLUM ARTHROPODA
  - Class Crustacea
    - Ostracoda sp.#1
    - Ostracoda sp.#2
    - Leptostraca sp.
    - Order Cumacea
      - Diastylidae sp. #1
      - Diastylidae sp. #2
      - Diastylidae sp. #3
    - Order Tanaidae
      - Tanaidae sp.
    - Order Amphipoda
      - Amphipoda sp.#1
      - Amphipoda sp.#2
      - *Atylus taupo*
      - *Liljeborgia hansoni*
      - Lysianassidae sp.
      - Oededicerotidae sp.
      - *Photis nigrocula*
      - Phoxocephalidae sp.#1
      - Phoxocephalidae sp.#2
    - Order Isopoda
      - Anthuridae sp.
      - Glycerida sp.
      - Janiridae sp.
    - Order Decapoda
      - *Helice crassa*
  - Class Pycnogonida
    - *Achelia dohrni*
  - Class Ophiuroidea
    - *Amphiura aster*
  - Class Echinoidea
    - *Patiriella regularis*
    - *Fellaster zelandiae*

Table 2. List of benthic organisms recorded from Little Akaloa, 1985-86.

Tanaidacea. A Pycnogonida and 2 species of Echinodermata were also recorded.

Replicates from both benthic sample sites were combined and represented as percentage abundance figures (Table 3). Seasonal data were also combined into another "all samples" group, with a total of 35 benthic samples. Polychaetes were consistently the most abundant infaunal group with values as high as 85.2% of all individuals recorded in winter. Capitellidae, Maldanidae, *Orbina papillosa* and *Scoloplos* sp. were present all year, dominating the polychaetes. Amphipoda represented 8-31.5% and Bivalvia 0.5-5.5%.

Seasonal changes in benthic macroinvertebrate communities are well documented (Boesch 1973, Kikuchi & Tanaka 1978, Watling 1975, Whitlach 1977). Figure 2 describes the mean number of invertebrates from the major groups. Polychaetes and crustaceans reached peak abundance in autumn to early winter, and declined to a minimum in summer. Polychaete numbers were lowest during early summer (450 m^{-2}) and highest during winter (2480 m^{-2}). High polychaete numbers during winter were primarily due to the heavy concentration of Capitellidae. The percent abundance of

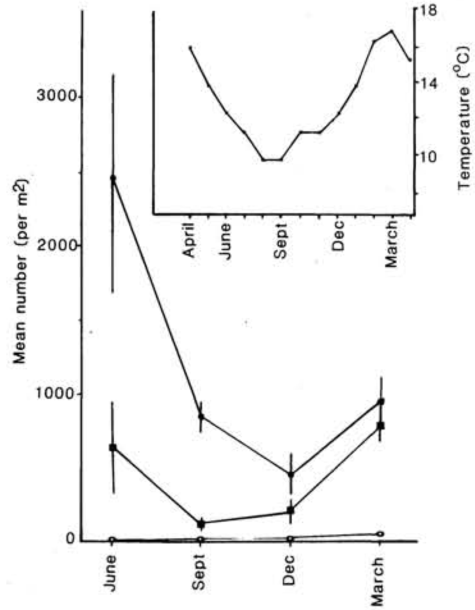

Figure 2. Mean number of benthic organisms (m^{-2}) collected seasonally from Little Akaloa, 1985-86. ● = Polychaetes, ▪ = Crustaceans, o = Molluscs. Insert represents Canterbury coastal sea temperatures.

	JUNE $n=5$	SEPT $n=10$	DECEMBER $n=10$	MARCH $n=10$	ALL MONTHS $n=35$
Gastropoda	2.3	-	0.5	0.6	1.2
Bivalvia	0.5	3.1	51	5.5	2.1
Capitellidae	39.0	25.0	9.1	1.4	20.4
Maldanidae	0.5	7.0	1.0	4.6	3.2
Orbina papillosa	3.7	5.5	2.0	14.6	7.3
Scoloplos sp.	13.5	1.6	10.1	10.0	8.5
Total Polychaeta	80.9	85.2	63.6	3.9	64.4
Cumacea	1.4	1.6	-	-	0.8
Ostracoda	2.3	2.3	3.0	2.3	2.4
Total Amphipoda	11.2	8.6	17.1	31.5	18.3
Phoxocephalid spp.	1.9	6.3	12.1	15.5	10.7
Isopoda	2.8	-	4.0	0.9	1.8
Decapoda	-	-	2.0	-	0.3
Achelia dohrni	0.5	-	-	-	0.2
Tanaidacea	-	-	-	2.7	0.9
Ophiuroidea	0.5	-	1.0	-	0.6
Total Number 0.0125 m^{-2}	43.0	12.8	9.9	21.9	18.8

Table 3. Percentage abundances of benthic faunas collected from Little Akaloa, June 1985 to March 1986.

MONTH AND SEASON	n	S	H	SR	J
June (Winter)*	215	26	2.143	4.655	0.6577
September (Spring)	130	23	1.586	4.520	0.5058
December (Summer)	100	28	1.779	5.865	0.5339
March (Autumn)	220	35	4.198	6.304	1.1808

Table 4. Number of individuals (n), number of species (S), species diversity (H) species richness (SR) and evenness (J) for each season (10 samples covering a total of 0.125 m^2, * 5 samples covering 0.0625 m^2) from Little Akaloa.

molluscs remained relatively constant over the entire sampling period, with the bivalve *Mactra ovata* and the gastropod *Amalda australis* present in most samples. The nut shell *Nucula hartvigiana* occurred sporadically and in low numbers.

Table 4 lists for each season the species diversity (H) and its components (species richness (SR) and evenness (J)) for Little Akaloa. Species diversity varied seasonally with highest values during autumn (4.198) and winter (2.143), while low values occurred during spring (1.586) and summer (1.779). High species diversity values corresponded with warmer water temperatures (Fig. 2). Similarly, low diversity values were recorded during the cooler months between September and December. Species richness and evenness values showed similar patterns.

EPIBENTHIC FAUNA

A total of 11 species of drift algae were collected: 8 from Little Akaloa and 7 from both Brighton Beach and Taylors Mistake (Table 5). *Entermorpha* sp. and *Ulva* sp. probably originated from sheltered locations, while *Macrocystis pyrifera, Plocamium* sp. and *Ballia callitricha* came from more exposed sites. All species grow on the northern side of Banks Peninsula and provide a source of drift algae following storms (pers. obs.).

Fifty-four animal species were recognised from drift algae samples (Table 6). Little Akaloa possessed 45 species, Brighton Beach, 30, and Taylors Mistake, 24 species. Decapods dominated the fauna with 11 species, followed by 8 mollusc, 7 polychaete, and 6 amphipod species. Also present were representatives of the Turbellaria,

ALGAE	ORIGIN	BRIGHTON BEACH	TAYLORS MISTAKE	LITTLE AKALOA
Chlorophyceae				
Enteromorpha sp.	S,R			*
Ulva sp.	S,Z	*	*	*
Phaeophyceae				
Carpophyllum sp.	M,R	*		*
Cystophora sp.	S,R	*		*
Macrocystis pyrifera	M,R	*	*	*
Sytouthamnus sp.	M,R		*	
Rhodophyceae				
Ballia callitricha	E,R		*	
Gigartina sp.	E,R	*	*	*
Plocamium sp.	E,R	*	*	*
Rhodymenia sp.	E,R	*	*	
Terrestrial		*	*	*

Table 5. Drift algae representations at the three sample locations. Type of shore exposure where living algae originated are given: Sheltered shore origin (S), Moderate (M), Exposed (E), Rocky shore (R), Soft bottom (Z).

Nematoda, Ostracoda, Mysidacea, Echinodermata and Pisces (Table 6). Eighteen species were recorded from all areas, of these 5 species were decapods.

Percentage abundances of the epibenthic fauna derived from combined replicates are shown in Table 7. Amphipoda were the most abundant group at all sites and seasons. Amphipods comprised 77-95% of the total numbers at Little Akaloa (Fig. 3), 40-75% at Brighton Beach and 65-66% at Taylors Mistake. *Atylus taupo* and *Allorchestes* sp. were present at all sites and constituted the majority of amphipods. The green lipped mussel, *Perna canaliculus* was patchily distributed, occasionally being found on hydroid colonies at Brighton and Taylors Mistake (362 per 110 g wet algae). Decapods were collected at all sites and represented the second most abundant group (2-26%). Five species of Hymenosomatid crab were

Records	Taxon
	PHYLUM COELENTERATA
* ¡	Hydroid sp.
	PHYLUM PLATYHELMINTHES
*	Turbellaria
	PHYLUM NEMATODA
*	
	PHYLUM MOLLUSCA
	Class Gastropoda
* ¡ ¿	*Amalda australis*
¿	*Melagraphia aethops*
*	Patellidae sp.
*	Pleurobranchiidae sp.
*	*Xymene* sp.
	Class Polyplacophora
*	Chitonidae sp.
	Class Cephalopoda
*	*Sepioloidea pacifica*
	Class Bivalvia
¡ ¿	*Perna canaliculus*
	PHYLUM ANNELIDA
*	*Cirriformia* sp.
*	Eunicidae sp.
*	*Lumbrinereis* sp.
* ¡ ¿	Nereidae sp.
*	*Orbina papillosa*
* ¡ ¿	*Perinereis* sp.
¡	Sigalionidae sp.
	PHYLUM ARTHROPODA
	Class Crustacea
*	Ostracoda sp.
	Order Mysidacea
* ¡ ¿	Mysid sp.
	Order Cumacea
*	Diastylidae sp. #1
*	Diastylidae sp. #2
*	Diastylidae sp. #3
	Order Amphipoda
* ¡ ¿	Amphipoda sp. #1
* ¡ ¿	Amphipoda sp. #2
* ¡ ¿	Amphipoda sp. #3
* ¡ ¿	*Allorchestes* sp.
* ¡ ¿	*Atylus taupo*
* ¡	Phoxocephalidae sp.
	Suborder Cymamidae
*	Caprellidae sp.
	Order Isopoda
* ¡	Aegidae sp.
*	Anthuridae sp.
* ¡ ¿	*Zenobiana tubicola*
	Order Decopoda
* ¡	*Cancer novaezelandiae*
* ¡ ¿	*Crangon* sp.
*	*Hemigrapsus crenulatus*
*	*Halicarcinus cookii*
* ¡	*H. innominatus*
*	*H. pubescens*
* ¡ ¿	*Hymenosoma depressum*
* ¡ ¿	Megalopa
* ¡ ¿	*Ovalipes catharus*
¡ ¿	Peneidae sp.
* ¡ ¿	*Petrolisthes elongatus*
	Class Pycnogonida
* ¡	*Achelia dohrni*
	Class Ophiuriodea
*	*Amphiura aster*
	Class Echinoidea
* ¡ ¿	*Patiriella regularis*
* ¡ ¿	*Fellaster zelandiae*
	PHYLUM CHORDATA
	Subclass Teleostei
¡	*Aldrichetta foresteri*
* ¡ ¿	*Pseudophycis bachus*
¡	Rajidae sp.
* ¡ ¿	*Rhombosolea retiaria*
¡ ¿	*Sphoeroides richei*

Table 6. List of epibenthic organisms recorded from Little Akaloa, Brighton Beach and Taylors Mistake during 1985-86. Records from: * Little Akaloa, ¡ Brighton Beach, ¿ Taylors Mistake

	LITTLE AKALOA					BRIGHTON BEACH		TAYLORS MISTAKE	
	JUNE $n=5$	SEPT. $n=10$	DEC. $n=5$	MAR. $n=5$	ALL $n=25$	OCT. $n=3$	MAR. $n=5$	OCT. $n=3$	MAR. $n=3$
Turbellaria	0.3	-	-	-	*	-	-	5	-
Nematoda	1.4	-	-	-	*	-	-	-	-
Gastropoda	0.3	-	1.2	-	0.5	-	0.1	-	1.2
Chitonidae	-	-	0.1	-	*	-	-	-	-
Perna canaliculus	-	-	0.6	2.7	0.8	-	46.2	5	-
Total Polychaeta	2.1	-	0.6	2.7	0.8	0.3	0.8	5	4.8
Cumacea	0.3	-	-	-	*	-	-	-	-
Mysidacea	4.5	-	0.1	-	0.8	17.6	0.3	2.8	0.9
Ostracoda	1.6	-	-	-	*	-	-	-	-
Allorchestes sp.	26.4	49.7	71.2	66.1	56.7	64.0	39.5	56.7	52.4
Atylus taupo	4.5	35.5	9.9	2.9	17.1	10.7	-	5	-
Total Amphipoda	83.8	95.9	88.7	77.1	90.4	75.7	40.0	64.5	65.7
Zenobiana tubicola	1.2	*	0.6	0.7	0.6	4.6	6.5	5	-
Total Isopoda	2.1	*	0.6	1.4	0.8	-	7.1	-	1.6
Decapoda	3.4	1.5	4.5	10.0	3.3	1.6	5.7	12.8	26
Achelia dohrni	0.9	1.5	3.5	3.5	2.4	0.3	-	-	-
Echinoidea	-	-	-	3.5	0.3	-	-	-	-
Ophiuroidea	-	-	-	-	-	-	0.2	-	-
Pisces	-	-	0.8	1.1	0.4	-	0.3	-	-
Total Number per 100 grams wet algae	865	518	643	135	435	2243	806	284	267

Table 7. Percentage abundances of epibenthic organisms collected from June to March 1985-86. An * indicates less than 0.1% of total sample.

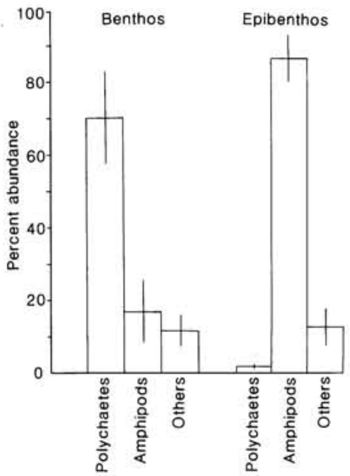

Figure 3. Percent abundance of three major taxon catergories in the benthos and epibenthos at Little Akaloa, collected June to March, 1985-86. Error bars represent 95% confidence limits.

collected throughout the year.

Results suggest that most animals associated with the epibenthic drift algae are seasonally abundant. Epibenthic faunas at Little Akaloa were highest in winter, spring and summer, whereas at Brighton Beach and Taylors Mistake the highest densities were recorded in spring and to a lesser extent, autumn. Large numbers of invertebrates recorded at Brighton Beach were associated with large quantities of *Ulva* sp. which was washed out of the Avon-Heathcote Estuary. Two months later, no *Ulva* was collected and the large invertebrate population had declined to a low level.

DISCUSSION

BENTHIC FAUNA

The benthic communities from subtidal habitats at Little Akaloa were dominated by relatively few species. This feature is consistent with overseas and local trends (Boesch 1973, Watling 1975, Kikushi & Tanaka 1978, Fenwick 1984). Seasonal changes in faunal assemblages recorded at Little Akaloa probably represent successional changes in the fauna. In soft bottom habitats, seasonal recruitment and growth rates of dominant species result in seasonal compositional changes (Kikushi & Tanaka 1978). Polychaetes such as *Orbina papillosa, Scoloplos* sp. and Capitellidae were largely responsible for the dramatic seasonal changes observed at Little Akaloa.

The fauna from the sheltered mud-silt substrata of Little Akaloa contrasted with the fauna collected by Knox *et. al.* (1978) from the wave exposed fine sand flats of Spencerville, Pegasus Bay (30 km north-west of Little Akaloa). Particular species associated with the high energy surf zone of Spencerville, including the bivalve *Mactra discors*, the amphipod *Patuka breviuropodus* and the shrimp *Callianassa filholi* were missing from Little Akaloa collections. Of the 58 species recorded at Little Akaloa only 44% were found at Spencerville. Boesch (1973), found that substrate type was the overwhelming factor responsible for the spatial patterns of species distribution in the Hampton area, Virginia. Similar conclusions were made by Knox *et. al.* (1978) and Knox and Fenwick (1978) at Spencerville and Hawkes Bay. Sand substrates may provide greater interstitial living space to the infauna than do mud bottoms, where infauna are limited to the looser packed particles near the sediment surface. The predominance of fine sand at Brighton Beach and silt/clay at Little Akaloa may account for many of the observed differences in benthic community structure in my study.

EPIBENTHIC FAUNA

Winter storms and rolling swells in summer deposit large quantities of algae on the sediment surface around Banks Peninsula. This drift algae is colonised in high densities by many invertebrate species. Both the amount and the type of drift algae influence the organisms which utilize this resource.

The macrofauna associated with decaying drift algae in the Banks Peninsula region appeared to be temporary residents. Population densities of macroinvertebrates were high when algae were plentiful and low when drift algae had dissappeared. When algae is consumed it is unclear what happens to the invertebrates associated with it. It seems probable that population booms and crashes coincide with the seasonal deposition of drift algae.

Although sediment type, water temperature, wave exposure and invertebrate recruitment may account for much of the benthic and epibenthic community structure observed, various authors have suggested that predation may also have a significant impact on invertebrate community composition (Virstein 1977, 1979, Holland *et. al.* 1980, Blundon & Kennedy 1982, Chilton & Bull 1984). Tube-dwelling polychaetes and small, fast moving epibenthic organisms (both common in this study) may escape predation because of their respective habits. Bivalves, decapods, mysids, and teleosts living close to the bottom may be vulnerable to predation (Virstein 1977, 1979), and were relatively uncommon in this study. These species dominate the diet of the paddle crab *Ovalipes* (Davidson 1987, Wear & Haddon 1987), which is common around Banks Peninsula (pers. obs.). However, the relationship between predation (perhaps by *Ovalipes*), physical factors and the benthic and epibenthic communities of Banks Peninsula will require further study.

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